PATENT SPECIFICATION

DRAWINGS ATTACHED

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876,255

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International Classification:—F06b. B23j, k, p.

COMPLETE SPECIFICATION

A Tubular Rivet Assembly and Method of Making same

We, OLYMPIC SCREW & RIVET CORPORATION, having its principal place of business at 11445 South Dolan Street, California, United States of America, a Corporation organized under the laws of the State of California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates in general to a tubular rivet assembly and to a method of and apparatus for manufacturing a component of such an assembly, a primary object of the invention being to provide a tubular rivet assembly capable of producing high clinching forces when set.

As general background, a tubular rivet assembly of the type to which the present invention relates comprises a stem having thereon a tubular rivet which includes a sleeve having a head at one end and a tail at its other end, the stem being provided at one end thereof with tail flaring means adjacent and engageable with the tail of the tubular rivet and being provided with gripper engageable means at the other end thereof. Preferably, the stem is provided with an enlarged shank adjacent the tail flaring means and is provided with a weakened zone intermediate such shank and the gripper engageable means.

In setting a rivet assembly of the foregoing type, the assembly is inserted through registering holes in elements to be riveted together so that the tail of the tubular rivet and the tail flaring means on the stem are on one side of such elements and the head of the tubular rivet and the gripper engageable means are on the opposite side thereof. A riveting tool having pressure and pulling members is then applied to the rivet assembly with the pressure member seated against the head of the tubular rivet and with the pulling member in engagement with the gripper engageable means on the stem. The pulling member is then moved axially of the pressure member to draw the enlarged shank of the stem into the sleeve of the tubular rivet so as to expand the sleeve into engagement with the elements to be riveted together, and to draw the tail flaring means on the stem into tail flaring engagement with the tail of the tubular rivet, thereby clamping the elements which are to be riveted together between the head of the tubular rivet and flared tail thereof. Eventually, the stem of the rivet assembly is broken off at the weakened zone therein and any excess portions of the stem may be trimmed off flush with the head of the tubular rivet.

An important object of the present invention is to provide a rivet assembly of the foregoing type, wherein the external surface of the sleeve of the tubular rivet is longitudinally grooved from the tail of such sleeve toward the head thereof so that, as the tail flaring means on the stem is drawn into the sleeve, the sleeve is split longitudinally into a plurality of prongs which engage one side of the assembly of elements to be riveted together, the head on the tubular rivet engaging the opposite side thereof. A related object is to provide a tubular rivet the tail of which is provided with transverse notches extending from the internal surface of the sleeve to the external surface thereof and communicating with the longitudinal grooves in the external surface of the sleeve. These notches facilitate initiation of the splitting of the sleeve along the longitudinal grooves in the external surface thereof, which is an important feature.

Another important object of the invention is to provide a rivet assembly incorporating means for causing the prongs resulting from splitting of the sleeve to curl outwardly as the tail flaring means is drawn into the sleeve. This outward curling of the prongs resulting

from splitting of the sleeve produces high clinching forces, which is an important feature.

Another object of the invention is to provide a tubular rivet which is so formed during the manufacture thereof that the prongs resulting from splitting of the sleeve inherently tend to curl outwardly as the sleeve is split. A related obpect is to provide the tail flaring means on the stem with a concave annular surface which engages the internal surface of the sleeve to force the prongs outwardly and which augments the inherent curling tendency of the prongs.

Another object is to provide a tubular rivet in which the density of the material forming the sleeve increases towards the internal surface thereof so that, as the sleeve is divided into prongs, these prongs tend to curl outwardly as the stresses therein resulting from the non-uniform density are relieved.

Another object of the invention is to provide a method of forming a tubular rivet of the foregoing type from a solid bar of material which includes the steps of upsetting one end of the bar to form the head of the rivet, compacting a central zone of the bar axially of the bar and adjacent the other end thereof, and subsequently drilling an axial bore through the bar to form the sleeve of the tubular rivet, such method also including the step of longitudinally grooving the external surface of the bar from said other end thereof in a direction toward said one end thereof to provide the longitudinal grooves which permit splitting of the sleeve into prongs upon drawing of the tail flaring means on the stem into the sleeve.

More particularly, an object of the invention is to provide a method wherein the step of compacting the central zone of the bar of which the tubular rivet is formed includes centre punching the headed end of the bar in a direction axially of the bar to a depth exceeding the axial dimension of the rivet head, this being done simultaneously with the upsetting of one end of the bar to form the rivet head. Subsequently, an axial bore is drilled through the bar from the bottom of the recess formed by the centre punching step to the other end of the bar to form the sleeve of the tubular rivet.

Another object is to provide die means capable of performing the foregoing method and including mating dies relatively movable toward and away from each other in an axial direction, the dies providing a head-forming cavity and a sleeve-forming cavity which communicates with and extends axially from the head-forming cavity, one of the dies carrying a centre punch which projects axially through the head-forming cavity into the sleeve forming cavity with means for longitudinally grooving the external surface of the sleeve of the tubular rivet in the manner hereinbefore described.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results thereof which will be evident to those skilled in this art in the light of the present disclosure, may be attained with the exemplary embodiments of the invention which are illustrated in the accompanying drawings and which are described in detail hereinafter. Referring to the drawings:

Figures 1, 2, 3, 4 and 5 of the drawings illustrate successive steps of the method of the invention for manufacturing a tubular rivet of a blind rivet assembly of the invention;

Figure 6 is a longitudinal sectional view of the tubular rivet;

Figure 7 is an end elevational view of the tubular rivet, taken as indicated by the arrowed line 7—7 of Figure 6;

Figure 8 is a side elevational view of the complete blind rivet assembly of the invention;

Figures 9, 10, 11 and 12 are longitudinal sectional views illustrating successive steps in the setting of the blind rivet assembly illustrated in Figure 8 of the drawings; and

Figures 13, 14 and 15 are end elevational views respectively taken along the arrowed lines 13—13, 14—14 and 15—15 of Figures 9, 10 and 12, respectively, Figure 13 being partially in section.

Referring first to Figure 8 of the drawings, the completed blind rivet assembly of the invention is designated generally by the numeral 20 and includes a stem 22 having thereon a tubular rivet 24. The latter includes a sleeve 26 having a tail 28 and a head 30 at opposite ends thereof, a sealing washer 32 being carried by the sleeve 26 in engagement with the underside of the head 30 for installations in which a fluid-tight seal is required. The external surface of the sleeve 26 is provided with longitudinal grooves 34 therein which extend from the tail 28 toward the head 30, these grooves preferably terminating short of the head. The tail 28 is provided with transverse notches 36 therein which form continuation of the respective grooves 34 and which extend from the external surface of the sleeve 26 to the internal surface thereon, as best shown in Figure 6 of the drawings. As will become apparent, the purpose of the notches 36 is to facilitate initiation of splitting of the sleeve 26 into prongs along the grooves 34. The depth of the grooves 34 should not exceed approximately one-half the thickness of the sleeve 26. For example, for a sleeve thickness of 0.40 inch, the groove depth should be approximately 0.15 inch to 0.20 inch.

The stem 22 is provided at one end thereof with tail flaring means 38 adjacent and engageable with the tail 28 of the sleeve 26,

the tail flaring means 38 comprising an enlargement 40 on the stem having a rounded, concave, annular surface 42 for tail flaring engagement with the internal surface of the sleeve 26 as will be described. The tail flaring means 38 terminates in an enlarged shank 44 which tapers into the body of the stem 22, as indicated at 46. Adjacent the enlarged shank 44 is a weakened zone 48 in the stem 22, this weakened zone being performed by providing the stem with an annular groove therein. The stem 22 is provided, at the end thereof opposite the tail flaring means 39, with gripper engageable means 50, the means 50 being engageable by a gripping means on the pulling member of a rivetting tool to be described. While a particular form of gripper engageable means 50 has been illustrated, it will be understood that other types of gripper engageable means may be substituted therefor.

Considering now the method of the invention of manufacturing the tubular rivet 24 of the invention, the starting material is preferably cylindrical bar stock 52, as shown in Figure 1 of the drawings. The bar stock 52 may be of any suitable material, aluminum being an example. As shown in Figure 2 of the drawings, a bar 54 is cut from the bar stock 52 as the next step in the method of the invention.

Referring to Figures 3 and 4 of the drawings, the bar 54 is placed between two relatively movable dies 56 and 58. In Figure 3 of the drawings, the dies 56 and 58 are shown open without the bar 54 in place, and in Figure 4, the dies are shown closed with the bar 54 in a partially processed condition. The die 56 is provided therein with a head-forming cavity 60 and the die 58 is provided therein with a cavity 62 for forming the exterior of the sleeve 26 of the tubular rivet 24, the cavity 62 being referred to as a sleeve-forming cavity for convenience. The upper die 56 is provided with a centre punch 64 which projects into the head-forming cavity 60 in a direction axially of the sleeve forming cavity 62, the diameter of the centre punch 64 being somewhat less than the diameter of the sleeve-forming cavity. The peripheral wall of the sleeve-forming cavity 62 is provided with ribs 66, preferably four in number, for forming the grooves 34 in the external surface of the sleeve 26 and the transverse notches 36 in the tail 28 of the sleeve.

As will be apparent from inspection of Figures 3 and 4 of the drawings, when the bar 54 is placed between the dies 56 and 58 and these dies are closed, one end of the bar is upset to form a head 68 thereon which approaches the final shape of the head 30. At the same time, the centre punch 64 forms an axial recess 70 in the upset head 68, the ribs 66 simultaneously forming the grooves 34 and the notches 36. Preferably, a centre punch 72 on the die 58 projects axially into the sleeve-forming cavity 62 in alignment with the centre punch 64 to form another axial recess 74. The effect of the centre punches 64 and 72, and particularly the centre punch 64, is to compact the material of the bar 54 axially in a central zone of the bar, the result of this increase in the density of the central zone being discussed hereinafter.

Referring now to Figure 5 of the drawings, the partly formed bar from the dies 56 and 58 is then placed in a die means comprising dies 76 and 78 to complete the external forming of the tubular rivet 24. The die 76 is provided therein with a head-forming cavity 80 conforming to the final configuration of the head 30 of the tubular rivet 24, and the die 78 is provided with a sleeve-forming cavity 82 conforming to the final external configuration of the sleeve 26. The peripheral wall of the sleeve-forming cavity 82 is provided with ribs 84 which correspons to the ribs 66 and which fit into and complete the formation of the grooves 34 and the notches 36 in the sleeve 26. The sleeve-forming cavity 82 is provided with a centre punch 86 which is insertable into the previously formed recess 74 in the partially processed bar 54. The die 76 is provided with a centre punch 88 which is insertable into the previously formed recess 70 and which projects axially through the head-forming cavity 80 into the sleeve-forming cavity 82 when the dies 76 and 78 are closed. The centre punch 88 deepens the previously formed recess 70 into a recess 90 which extends through the head 30 and therebeyond a substantial distance.

Upon closure of the dies 76 and 78, the bar 54 assumes the configuration illustrated in Figure 5 of the drawings. The centre punches 86 and 88 co-operate to further compact the material in a central zone therebetween to increase the density of the material in the zone for a purpose to be described.

Referring to Figure 6 of the drawings, an axial cylindrical bore 92 is drilled from the bottom of the recess 90 completely through the product resulting from closure of the dies 76 and 78 to form the finished tubular rivet 24. As a result of the compaction of the material of the bar 54 in a central zone thereof by the centre punches 64 and 72 and by the centre punches 86 and 88, the material of the final sleeve 26 will be denser adjacent the internal surface thereof than adjacent the external surface thereof. In other words, the density of the material forming the sleeve 26 increases radially from the external surface of the sleeve toward the internal surface thereof. Consequently, the material of the sleeve adjacent the internal surface thereof will be in a state of compression with respect to the material adjacent the external surface of the sleeve, this theory being essential to the theory of operation of the blind rivet assembly 20 which is presented hereinafter.

Referring now to Figure 9 of the drawings, the blind rivet assembly 20 is inserted into registering holes 94 and 96 through elements 100 and 102 which are to be riveted together to form an assembly 104, Figures 11 and 12. When the rivet assembly 20 is thus inserted into the holes 94 and 96, the tail 28 of the tubular rivet 24 and the tail flaring means 38 and the enlarged shank 44 on the stem 22 are disposed on one side of the assembly 104, while the head 30 of the tubular rivet and the gripper engageable means 60 on the stem are disposed on the opposite sides of the assembly. The washer 32, if used, under the head 30 is engageable with one side of the assembly 104.

With the rivet assembly 30 inserted through the assembly 104 in the foregoing manner, a suitable rivetting tool 106 is applied to the rivet assembly 20. More particularly, the riveting tool 106 is provided with a pressure member 108 adapted to seat on the head 30, and is provided with a pulling member 110 which is movable axially of the pressure member and which is provided with gripping means 112 for gripping the gripper engageable means 50 on the stem 22 of the rivet assembly. The foregoing conditions obtaining the pulling member 110 is moved axially of the pressure member 108 in a direction away from the assembly 104 to pull the stem 22 into the sleeve 26 of the tubular rivet 24.

Referring to Figure 10 as the stem 22 is moved axially of the tubular rivet 24 to pull it into the sleeve 26 the enlarged shank 44 on the stem first expands the sleeve 26 to at least substantially fill the holes 94 and 96 through the assembly 104. As the tail flaring means 38 engages the tail 28 of the tubular rivet 24, the sleeve 26 of this rivet splits along the longitudinal grooves 34 in the external surface thereof to form prongs 114, initiation of the splitting action being facilitated by the notches 36 across the tail 28 of the rivet 24. As the tail flaring means 38 forms the prongs 114, it spreads them outwardly as illustrated in Figures 10 and 11, these prongs curling outwardly, as shown in Figures 10, 11 and 12, as they are spread. This outward curling of the prongs 114 is due in part to the action of the concave surface 42 of the tail flaring enlargement 40, but, as will be explained hereinafter, is due primarily to the previously described compaction of the central zone of the bar 54 in the process of forming the tubular rivet 24. Ultimately, the tail flaring means 38 spreads the prongs 114 so that the outer ends thereof seat against one side of the assembly 104, as shown in Figure 11, further axial movement of the stem 22 resulting in pressing the outer ends of the prongs 114 solidly against one side of the assembly 104 to provide a very high clamping or clinching force between the prongs and the head 30, which is an important feature of the invention.

Eventually, the resistance to axial movement of the stem 22 relative to the tubular rivet 24 reaches a value such that it exceeds the tensile strength of the weakened zone 48 of the stem 22, whereupon the stem ruptures at such weakened zone as illustrated in Figure 11 of the drawings.

After rupture of the stem 22 in the foregoing manner, the stem may be trimmed off flush with the head 30 of the tubular rivet 24, as shown in Figure 12 of the drawings, to provide a finished appearance.

Considering now the previously mentioned theory explanatory of the outward curling of the prongs 114, part of the outward curling thereof is, as previously suggested, due to the curling action provided by the concave tail flaring surface 42. However, the action of this surface is responsible for only a part of the outward curling of the prongs 114, the outward curling of these prongs being due primarily to the hereinbefore described manner in which the tubular rivet 24 of the invention is formed. It is believed that the outward curling of the prongs 114 results primarily from the compacting of the central zone of the bar 54 by means of the centre punches 64 and 72 and the centre punches 86 and 88 in the process of forming the bar 54 into the tubular rivet 24. Apparently what occurs during the formation of the bar 54 into the tubular rivet 24 in the hereinbefore-described manner is that the material of the sleeve 26 is compacted more adjacent the internal surface of the sleeve than adjacent the external surface thereof, the density of the material forming the sleeve thus increasing radially from the external surface of the sleeve toward the internal surface thereof, despite the fact that the most-compacted central zone has been drilled out in forming the axial bore 92. Consequently, the material adjacent the internal surface of the sleeve 26 is in a state of axial compression relative to the material adjacent the external surface of the sleeve, or, in other words, the material adjacent the internal surface of the sleeve. Consequently, when the sleeve 26 is split into the prongs 114 at the notches 36 and along the longitudinal grooves 34, the stress differential between the interior and the exterior of the sleeve 26 is relieved, the inner surfaces of the prongs 114 expanding axially and the outer surfaces thereof contracting axially to cause the hereinbefore-described outward curling of the prongs. It has not been possible thus far to devise any means for measuring the actual residual stresses in the material of the sleeve 26 adjacent the internal and external surfaces thereof to determine whether the foregoing explanation of the outward curling of the prongs 114 is correct, but it is believed that it is.

Although exemplary embodiments of the

invention have been disclosed herein for purposes of illustration, it will be understood that various changes, modifications, and substitutions may be incorporated in such embodiment without departing from the invention as defined by the claims hereinafter appearing.

WHAT WE CLAIM IS:—

1. A tubular rivet comprising a sleeve having a head at one end and a tail at its other end, said sleeve having longitudinal grooves therein extending from said tail toward said head and a cylindrical bore extending throughout the length thereof, the internal surface of said sleeve being in a state of axial compression relative to the external surface thereof, so that, when said sleeve is split from said tail toward said head along said longitudinal grooves to form prongs, said prongs will curl reversely outwardly as the internal axial compression is relieved.

2. A tubular rivet as claimed in claim 1, wherein the longitudinal grooves are positioned on the external surface of said sleeve.

3. A tubular rivet as claimed in claim 1 or 2, wherein said tail is provided with transverse notches extending from the internal surface of said sleeve to the external surface thereof and communicating with the longitudinal grooves, respectively.

4. A tubular rivet assembly comprising a tubular rivet as claimed in claim 1, 2 or 3, and a stem extending through said tubular rivet and having at one end thereof tail flaring means adapted to split said sleeve along said longitudinal grooves or fissures by movement of said stem in a direction toward said head, said stem having grippable means at the other end thereof.

5. A tubular rivet assembly as claimed in claim 4, wherein the stem has a weakened zone intermediate said tail flaring means and said grippable means.

6. A tubular rivet assembly as claimed in claim 4 or 5, wherein said tail flaring means comprises an enlargement on said stem having a concave annular surface engageable with the internal surface of said sleeve.

7. A method of making a tubular rivet of claim 1, 2 or 3 from a solid bar of material comprising the steps of upsetting one end of said bar to form said head, axially compacting a central zone of said bar, while simultaneously longitudinally grooving a portion of the bar and forming an axial bore through said bar to form said sleeve.

8. A method as claimed in claim 7, wherein the central zone of said bar is compacted by centre punching said one end thereof to a depth exceeding the axial dimension of the head.

10. A method as claimed in claim 8 or 9, wherein the axial bore through said bar is formed by drilling through said bar from the bottom of the recess formed by centre punching said one end thereof, thereby providing a bore of uniform diameter through the length of said bar.

11. A method as claimed in claim 8, 9 or 10, wherein the bar is centre punched at both ends, simultaneously with the upsetting of one end to form the head.

12. A tubular rivet substantially as described with reference to the accompanying drawings.

13. A tubular rivet assembly substantially as described with reference to the accompanying drawings.

14. A method of making a tubular rivet from a solid bar of material having a head at one end and a tail at its other end substantially as described with reference to the accompanying drawings.

MARKS & CLERK.

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Fig. 1.

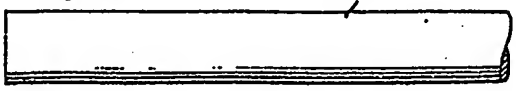

Fig. 2.

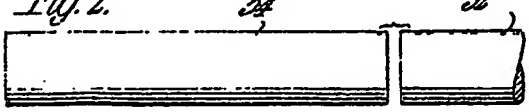

Fig. 3.

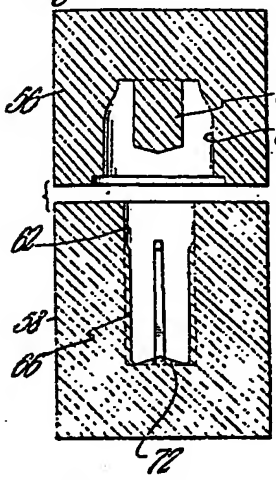

Fig. 4.

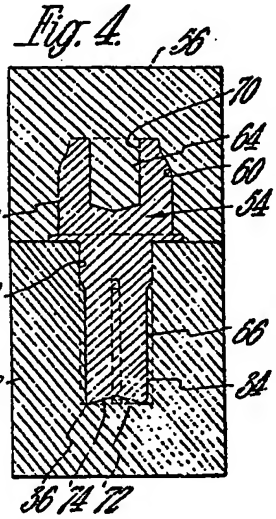

Fig. 8.

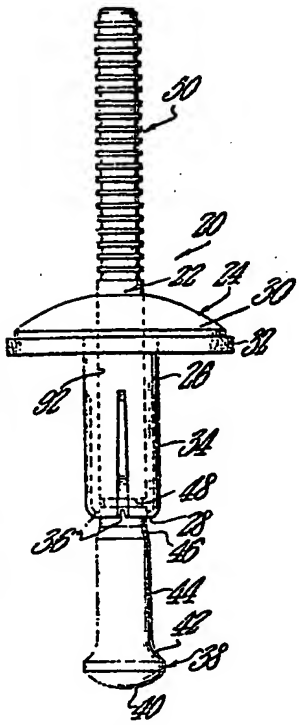

Fig. 5.

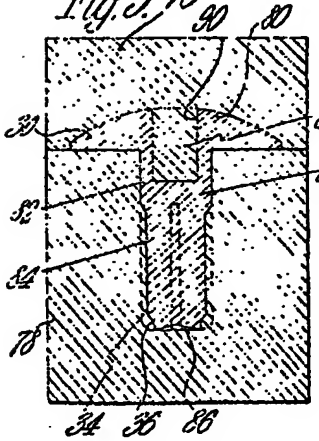

Fig. 6.

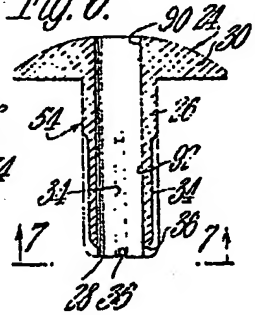

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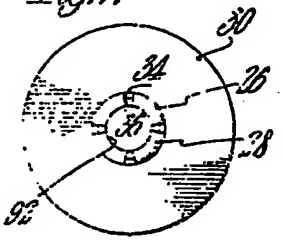
Fig. 7.



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SHEETS 1 & 2

Fig. 9.

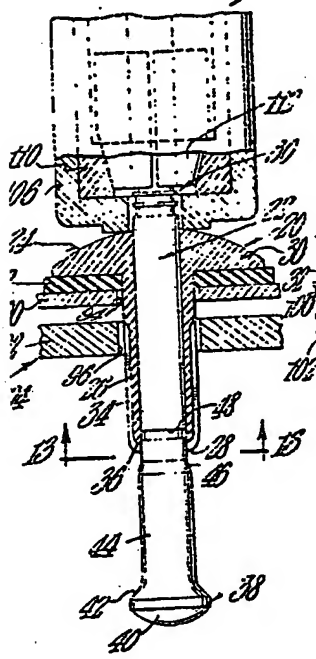


Fig. 10.

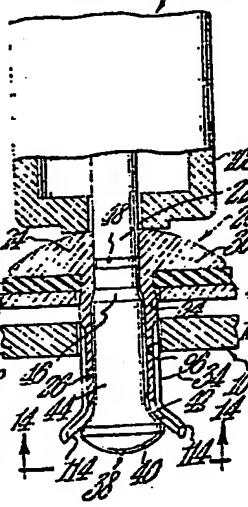


Fig. 11.

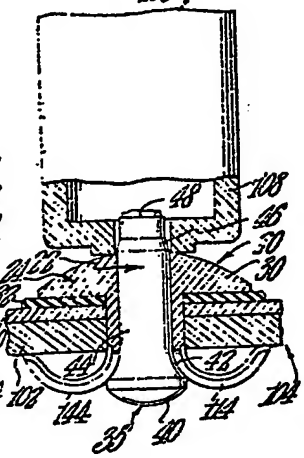


Fig. 12.

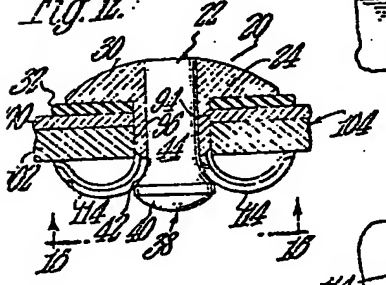


Fig. 13.

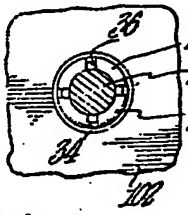


Fig. 14.

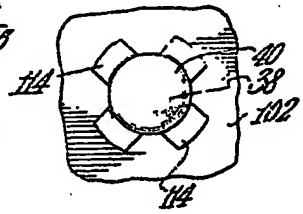
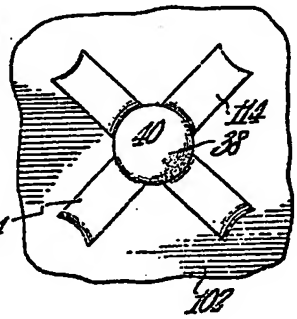


Fig. 15.



876,255 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2